importance of a firm mathematical foundation, and I am as far from wishing to overwhelm the younger boys with science before they have mastered the elements of arithmetic and grammar and languages as he can be. My experience amongst boys has, however, not been such as to enable me to say exactly when a thorough science teaching ought to begin.

The mistake, as it seems to me, which is prevalent respecting science teaching in schools, is the notion that it is a subject to be *lectured* upon for two hours per week to those already educated, and who show an aptitude for it, whilst it can, and ought to, be introduced at a definite period as a regular part of *school work*. It is now usually made an extra subject, a quasi-amusement, put on the same footing as drilling or drawing, whilst it can, and ought to, be made as much a discipline as the Latin grammar or Euclid, affording, as it does, in my opinion, if properly taught, an excellent training ground for acquiring that reasoning power and habit of application which it is usually supposed can only be gained through one or other of these older channels. I am sorry that Mr. Wilson thinks that any man of science is misleading public opinion on this subject. This is a serious charge, but as it rests on a misconception, I remain convinced that in the long run public opinion will endorse our views.

It is out of my power to tell Mr. Wilson whose business it is to make the change to a better state of things, which he himself feels to be necessary, for he admits that the new examination is adverse to scientific education. I do, however, feel strongly that unless the authorities of our great schools and the examining Boards set earnestly to work to introduce this new discipline and give it (as many of them to their honour are now beginning to do) a fair field and no favour, the beneficial influence which these schools have had on English education, must soon begin to diminish.

The Balliol scholarships and the other great University "advertisements" I believe to be in many ways stumbling-blocks in the path of true education in this country; "the many," as Mr. Wilson truly says, "are kept to swell the triumph of the few," and the prizes have to be got "at any cost to boy or school." Are we never to break loose from this degrading bondage to the Moloch of examination? I for one think better both of commissioners, governors, and head-masters, and look forward with hope to the ultimate emancipation of school-boys from their ancient fetters. Then those subjects will be taught at school which are best suited to make the mass of boys good citizens, and to forward the highest interests of the country, instead of the great aim of the schoolmaster being to secure a Balliol scholarship. We shall then see less than we do now of University men taking to sheep-farming in Australia, and hear less complaint of the superiority of our continental friends both in pure science and its application.

HENRY E. ROSCOE

PROF. FLOWER'S HUNTERIAN LECTURES ON THE RELATION OF EXTINCT TO EXISTING MAMMALIA [1]

IV.

IT was mentioned in the last lecture that no true Proboscideans have been found below the Miocene strata, but among the most remarkable of the numerous recent discoveries in the Eocene formations of Wyoming Territory, North America, has been that of a group of animals of huge size, approaching, if not equalling, that of the largest existing elephants, presenting a combination of characters quite unlike those known among either recent or extinct creatures, and of which there were evidently several species living contemporaneously. To form some idea of their appearance, we must imagine animals very elephantine in their general proportions, elevated on massive pillar-like limbs, with the same complete radius and ulna, the same short, round, five-toed feet which distinguish the elephants from all other known hoofed quadrupeds. The tail, as in the elephants, was long and slender, but the neck, though still short was not so much abbreviated as in modern Proboscideans, and there is no good evidence of their having possessed a trunk. The brain was exceedingly small for the size of the creature. The head differed greatly from that of the elephants, being long and narrow, more like that of a rhinoceros, and, as in that animal, was elevated behind into a great occipital crest, but unlike that or any other known mammal, it had developed from its upper surface, three pairs of conspicuous laterally diverging protuberances, one pair from the parietal region, one over or in front of the orbits, and one near the forepart of the elongated nasal bones. Whether these were merely covered by bosses of callous skin, as the rounded form and ruggedness of their extremities would indicate, or whether they formed the bases of attachments for horns of still greater extent, either like those of the rhinoceros or the cavicorn ruminants, must still be a matter of conjecture. But in either case they must have given a very strange aspect to the creature which possessed them, and have been formidable weapons in encounters either with animals of its own kind, or with the fierce carnivorous beasts whose remains are associated in the same deposits with them. There were no incisor teeth in the upper jaw, but a pair of huge descending canine tusks very similar in position and form to those of the musk-deer. Behind these, and at some distance from them, were, on each side above and below, six molar teeth of comparatively small size, placed in continuous series, each with a pair of oblique ridges, conjoined internally, and diverging externally in a V-like manner, and with a stout basal cingulum. The lower incisors and canines were small, and are only known at present by their sockets. The dental formula is—

$$i\,\frac{0}{3}\;c\,\frac{1}{1}\;p\,\frac{3}{3}\;m\,\frac{3}{3} = 34.$$

The first discovered evidences of the existence of animals of this group were described by Leidy in 1872, under the name of *Uintatherium*, from the Uintah Mountains, at the base of which they were found. Very shortly afterwards other portions of bones and teeth of either the same or closely allied forms, were described by Marsh as *Dinoceras*, and by Cope as *Loxolophodon* and *Eobasileus*. Whether these names will ultimately be retained for separate generic modifications, or whether they will have to be merged into the first, it would be premature to attempt to decide upon the evidence before us. A more important question is, what are the affinities of the animals, and what light do they throw on the general evolutionary history of the class to which they belong? Looking at the totality of their organisation as already known, at first sight they seem to present a considerable resemblance with the Proboscidea. The absence of the third trochanter, and of the fossa for the ligamentum teres on the femur, and the general form of the feet with their short broad toes are quite Proboscidean characters, but a closer examination of the structure of the carpus and tarsus, especially of the mode of union of the different bones with each other, shows more essential affinities with Rhinoceros. The same may be said of the cranium, so that on the whole they appear to come nearer to the Perissodactyle Ungulates than was formerly supposed. This relationship is strengthened by the discovery of other forms, constituting the genera *Bathmodon* and *Metalophodon* of Cope, of earlier geological age, which with the same general structure of the *Uintatheriidæ* retain in a most interesting manner many primitive characters, especially the complete number of incisor and premolar

[1] Abstract of a course of lectures delivered at the Royal College of Surgeons "On the Relation of Extinct to Existing Mammalia, with Special Reference to the Derivative Hypothesis," in conclusion of the course of 1873. (See Reports in NATURE for that year.) Continued from p. 356.

teeth. These are forms for fuller information upon which we anxiously wait.

The negative evidence (which of course must be received with the greatest caution in palæontology) of the absence of remains of any of these animals in the true Miocene or Pliocene deposits of North America, indicates that the race became extinct at least in that land, though it possibly may have emigrated elsewhere, and perhaps in Asia, may have laid the foundation of that family which first appears in the Old World under the more familiar aspect of typical Proboscideans. While, however, there are no grounds for assuming that the latter were derived directly from the Eocene Bathmodons and Uintatheriums, it is not too much to look upon these as affording some indications of the steps by which the process might have taken place, and, as such, their discovery is one of the most interesting that has been revealed by modern palæontological research.

It should be mentioned that Marsh, who has given us very full information upon the osteology and dentition of this group, has made of *Uintatherium* and its immediate allies a peculiar order of mammals, to which he gives the name of *Dinocerata*, while Cope, who formerly included them in the Proboscidea, and placed *Bathmodon* and its allies in the Perissodactyla, has recently formed an order called *Amblypoda*, containing two sub-orders, of which *Dinocerata* is one, and *Pantodonta* (*Bathmodon* and *Metalophodon*) the other.

The tertiaries of South America have yielded some very remarkable forms of mammalian life, the nature and affinities of which have greatly puzzled all zoologists who have attempted to unravel them. *Macrauchenia* has been already described among the Perissodactyle Ungulates, of which group it is undoubtedly a member, although in some characters somewhat aberrant. The articulation of the fibula with the calcaneum is an Artiodactyle, or perhaps generalised character. The teeth ally it to Palæotherium and Rhinoceros. *Homalodontotherium* from the banks of the River Gallegos, South-east Patagonia, is known by the teeth alone, which, though very generalised, are on the whole rhinocerotic. *Nesodon*, from the same locality, also only known by the dentition and some parts of the skull, connects the last and *Macrauchenia* with *Toxodon*. These three genera have the typical dental formula of $i\frac{3}{3}\ c\frac{1}{1}\ p\frac{4}{4}\ m\frac{3}{3} = 44$. *Toxodon* is an animal about the size of a hippopotamus, of which many specimens have now been found in Pleistocene deposits near Buenos Ayres, which have been described by Owen, Gervais, and Burmeister. The teeth consist of incisors, very small lower canines, and strongly curved molars, all with persistent roots; the formula being apparently $i\frac{2}{3}\ c\frac{0}{1}\ p\frac{4}{3}\ m\frac{3}{3} = 38$. The cranial characters exhibited a combination of those found in both Perissodactyles and Artiodactyles, but the form of the hinder part of the palate, the absence of an alisphenoid canal, and especially the tympanic being firmly fixed in between the squamosal and the exoccipital, ankylosed to both, and forming the floor of a long, upward directed meatus auditorius, is so exactly like that of the *Suina*, that it is difficult to believe that it does not indicate some real affinity to that group. These characters seem to outweigh in importance those by which some zoologists have linked it to the Perissodactyla, and the absence of the third trochanter, and the articulation of the fibula with the calcaneum tell in the same direction. The structure of the feet is not known, but it is probable that it had five toes on each.

Mesotherium, Serres, also called *Typotherium* by Bravard and Gervais, was an animal rather larger than a Capybara, and of much the same general appearance. Its skeleton is completely known, and shows a singular combination of characters, resembling Toxodon, or a generalised Ungulate on the one hand, and the Rodents, especially the *Leporidæ* on the other. In the presence of clavicles, of five toes on the fore-foot and four on the hinder, it differs from all existing Ungulates, and yet if it is considered as a Rodent, it must be looked upon as a most aberrant form. The teeth are $i\frac{1}{2}\ c\frac{0}{0}\ p\frac{2}{1}\ m\frac{3}{3} = 24$. Although our knowledge of many of these forms is still very limited, we may trace among them a curious chain of affinities, which, if correctly interpreted, would seem to unite the Ungulates on the one hand, with the Rodents on the other; but further materials are needed before we can establish with certainty so important a relationship, one which, if true, would alter materially some of the prevailing views upon the classification of mammals. It may be convenient provisionally to include those Ungulates which are neither *Artiodactyla* nor *Perissodactyla*, under a third heading, of which *Polydactyla*[1] would be the appropriate designation; though there is no evidence that they form such a homogeneous group as either of the other two.

(*To be continued.*)

PROF. HUXLEY'S LECTURES ON THE EVIDENCE AS TO THE ORIGIN OF EXISTING VERTEBRATE ANIMALS[2]

I.

TWENTY years ago the arguments as to the causes of the phenomena of organic nature, brought forward in support of the then recently advanced views of Mr. Darwin, were largely speculative; all one could hope to show was that no valid objections could be urged against the theory of evolution. But since that time "many have run to and fro and knowledge has been increased"; the question has come out of the region of speculation into that of proof; every day increases our familiarity with the phenomena of life on the globe in antecedent ages, and so gives us the only valid evidence obtainable as to the evolution of living things.

When we consider any animal at the present day there are three hypotheses which may be put forward with regard to its origin: that it arose out of nothing, that it had its origin from dead inorganic matter, or that it arose as a modification of some pre-existing living being. It is hardly worth while to consider the two first of these hypotheses—for the first it would be utterly impossible to obtain any evidence, and the second is devoid of all ground of analogy, and opposed to all our knowledge of what actually takes place. The last, on the other hand, should, if true, be capable of some sort of proof—at any rate it can be brought to the test of facts.

It is quite conceivable that all evidence as to the origin of an animal may have disappeared, and that the problem becomes, in consequence, insoluble by direct evidence, analogy and probability being the only guides left. As a matter of fact, however, we possess in the 70,000 feet of stone, gravel, sand, &c., which form the earth's crust, fossil remains imbedded in chronological order, and in many cases so perfectly preserved, that all important details can be made out almost as well as in the recent state.

The plan adopted in these lectures will be not to give all obtainable evidence with regard to the origin of each group of vertebrate animals, but to select from each class one or two definite cases of living animals, and to see what evidences can be obtained, by going back in time, as to the way in which they have come about, or at any rate as to the extent of the duration of their existence.

[1] An extension of the order *Toxodontia* of Owen, and *Ungulata multidigitata* of Burmeister.

[2] A course of six lectures to working men, delivered in the theatre of the Royal School of Mines. Lecture I., Feb. 28.